

# EXHIBIT 12



**LM230W02**  
**Liquid Crystal Display**

Product Specification

# SPECIFICATION FOR APPROVAL

- ( ) Preliminary Specification  
 (●) Final Specification

Title	23.0" WUXGA TFT LCD
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BUYER	HP
MODEL	

SUPPLIER	LG.Philips LCD Co., Ltd.
*MODEL	LM230W02
Suffix	A2

\*When you obtain standard approval,  
 please use the above model name without suffix

SIGNATURE	DATE
/	
/	
/	

Please return 1 copy for your confirmation with your signature and comments.

SIGNATURE	DATE
<u>S.G.Hong / G.Manager</u>	
<b>REVIEWED BY</b>	
<u>J.Y.Choi / Manager</u>	
<b>PREPARED BY</b>	
<u>J.H Kim / Engineer</u>	

**MNT Products Engineering Dept.**  
**LG. Philips LCD Co., Ltd**



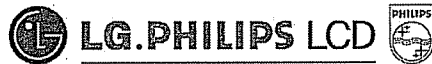
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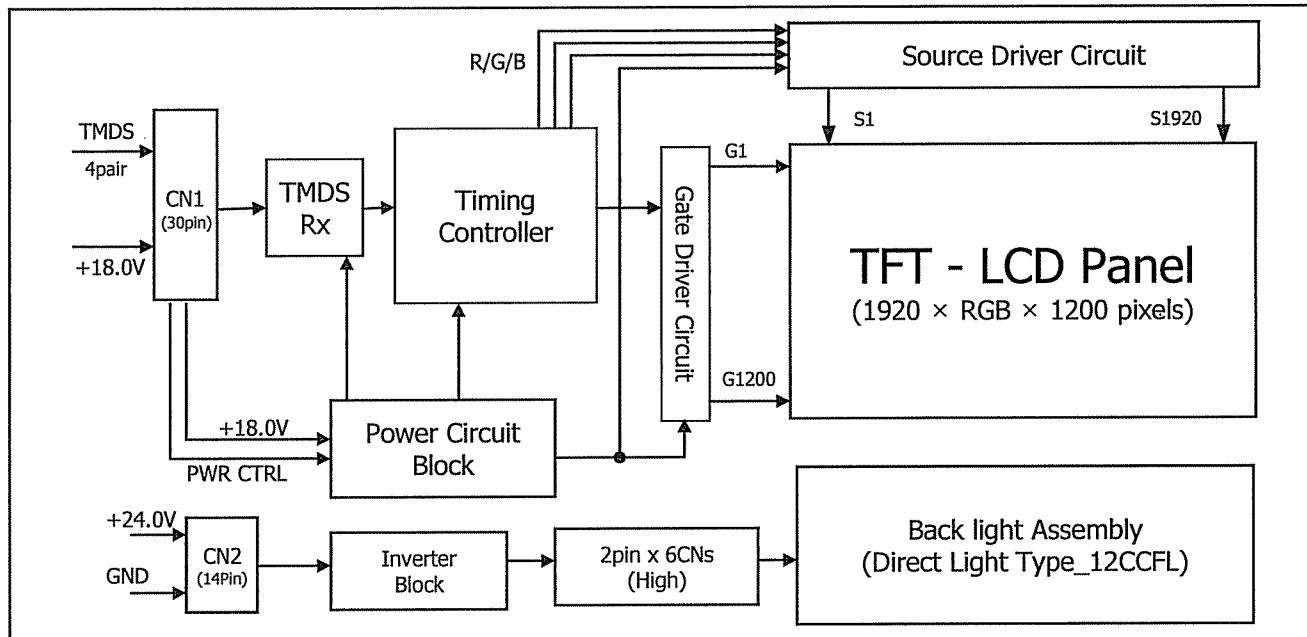
## LM230W02 Liquid Crystal Display

### Product Specification

#### 1. General Description

The LM230W02 LCD is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Lamp(CCFL) back light system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally black mode. This TFT-LCD has a 23.0 inch diagonally measured active display area with WUXGA resolution(1200 vertical by 1920 horizontal pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the luminance of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,777,216 colors.

The LM230W02 has been designed to apply the TMDS™(Transition Minimized Differential Signaling) interface.



#### General Features

Active Screen Size	23.0 inches(58.4cm) diagonal
Outline Dimension	523.4(H) × 335.6(V) × 41.0(D) mm(Typ.)
Active Area	495.36[mm] × 309.6[mm]
Pixel Pitch	0.258 mm × 0.258mm
Pixel Format	1920 horiz. By 1200 vert. Pixels RGB stripes arrangement
Color Depth	8-bit, 16,777,216 colors
Luminance, CR	250 cd/m <sup>2</sup> , 500:1
Viewing Angle(CR>10)	View Angle Free (R/L 176(Typ.), U/D 176(Typ.))
Power Consumption	Total 56 Watt (Typ.) (Logic=5.6 W, Lamp=50.4 W)
Weight	2,870g(typ.)
Display Operating Mode	Transmissive mode, normally black
Surface Treatment	Hard coating(3H), Anti-glare treatment of the front polarizer
Interface	TMDS



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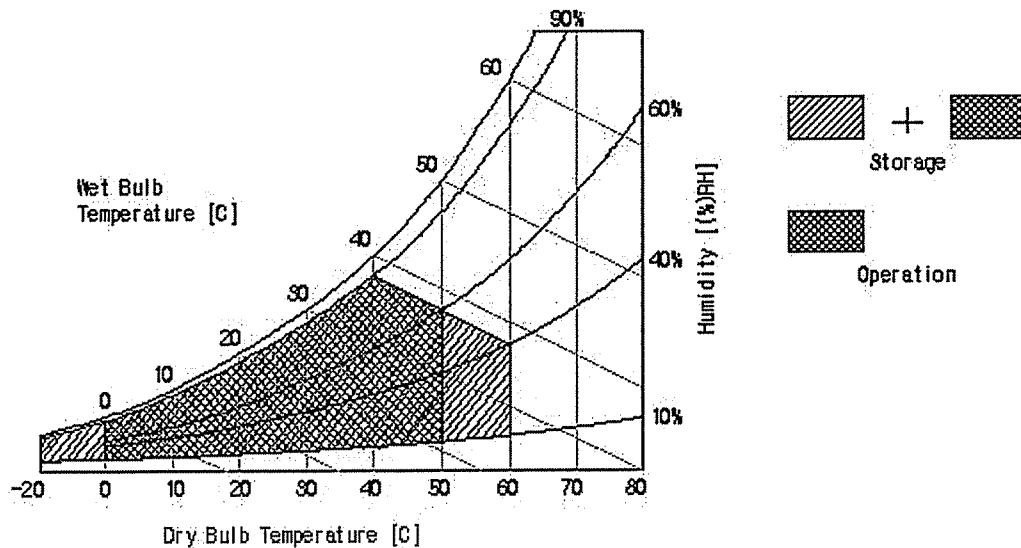
### 2. Absolute Maximum Ratings

The following are maximum values which, if exceeded, may cause operation or damage to the unit.

**Table 1. ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Input Voltage	V <sub>LCD</sub>	-0.3	21	Vdc	at 25 ± 2°C
Operating Temperature	T <sub>OP</sub>	0	50	°C	1
Storage Temperature	T <sub>ST</sub>	-20	60	°C	
Operating Ambient Humidity	H <sub>OP</sub>	10	90	%RH	
Storage Humidity	H <sub>ST</sub>	10	90	%RH	

Note : 1. Temperature and relative humidity range are shown in the figure below.  
Wet bulb temperature should be 39 °C Max, and no condensation of water.





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### 3. Electrical Specifications

#### 3-1. Electrical Characteristics

The LM230W02 requires two power inputs. One input is employed to power the LCD electronics and to drive the TFT array and liquid crystal. And the second input power for the CCFL / Backlight is to power the inverter.

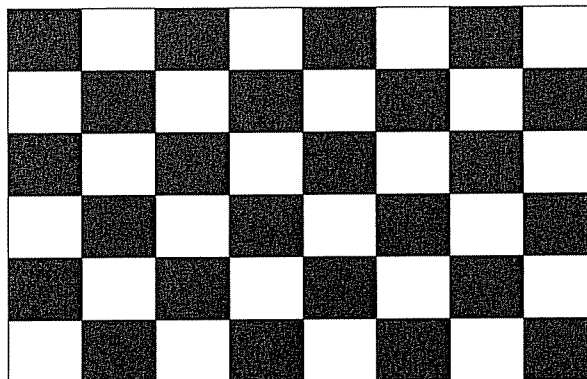
**Table 2-1. ELECTRICAL CHARACTERISTICS**

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	V <sub>LCD</sub>	17.0	18.0	19.0	V <sub>dc</sub>	
Power Supply Input Current	I <sub>LCD</sub>	-	310	357	A	1
		-	470	610	A	2
Power Consumption	P <sub>LCD</sub>	-	5.60	6.44	Watt	1
Rush current	I <sub>RUSH</sub>	-	-	3.0	A	3

Note :

1. The specified current and power consumption are under the V<sub>LCD</sub>=18.0V, 25 ± 2°C, f<sub>V</sub>=60Hz condition whereas mosaic pattern(8 x 6) is displayed and f<sub>V</sub> is the frame frequency.
2. The current is specified at the maximum current pattern.
3. The duration of rush current is about 2ms and rising time of power Input is 1ms(min.).

White : 255Gray  
Black : 0Gray



Mosaic Pattern(8X6)





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**Table 2-2. INVERTER ELECTRICAL CHARACTERISTICS**

Parameter	Symbol	Condition	Values			Unit	Notes
			Min.	Typ.	Max.		
Inverter :							
Input Voltage	V <sub>DDB</sub>		22.0	24.0	26.0	V	1
Input Current	I <sub>DDB</sub>	V <sub>BR</sub> = 3.3V	1.8	2.1	2.4	A	2
Input Power	PB	V <sub>BR</sub> = 3.3V	43.2	50.4	57.6	Watt	2
B/L on/off control	VON/OFF	Lamp ON = High	4.0	-	5.0	V	
		Lamp OFF =Low	0.0	-	0.8	V	
Brightness Adj	VBR		0	-	3.3	V	
LAMP :							
Life time			50,000			Hrs	3

Notes :

1. The input voltage ripple is limited below 400mVp-p.
2. The specified current and power consumption are under the typical supply Input voltage, 24V.
3. The life is determined as the time at which luminance of the lamp is 50% compared to that of initial value at the typical lamp current on condition of continuous operating at  $25 \pm 2^{\circ}C$ .
4. Electrical characteristics are determined after the unit has been 'ON' and stable for approximately 30min in a dark environment at  $25^{\circ}C \pm 2^{\circ}C$ .
5. The lamp must be turned on in condition of  $0^{\circ}C$  temperature.





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### 3-2. Interface Connections

This LCD employs Two interface connections, a 30 pin connector is used for the module electronics and a 14Pin Connector is used for the integral backlight system.

#### 3-2-1. LCD Module

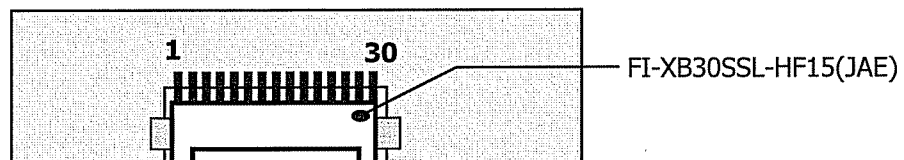
- LCD Connector(CN1):FI-XB30SL-HF, FI-XB30SSL-HF15 (Manufactured by JAE) or Equivalent
- Mating Connector : FI-X30C2L (Manufactured by JAE) or Equivalent
- Interface chips(LCD) : PTFP 403 PZP (TI)

**Table 3 MODULE CONNECTOR(CN1) PIN CONFIGURATION**

No	Symbol	Description	No	Symbol	Symbol
1	GND	Ground	16	OPEN	NC
2	SHLD2	Shield for TMDS channel 2	17	OPEN	NC
3	RX2+	TMDS Differential Output(+) (CH 2)	18	OPEN	NC
4	RX2-	TMDS Differential Output(-) (CH 2)	19	GND	Ground
5	SHLD1	Shield for TMDS channel 1	20	GND	Ground
6	RX1+	TMDS Differential Output(+) (CH 1)	21	GND	Ground
7	RX1-	TMDS Differential Output(-) (CH 1)	22	V <sub>LCD</sub>	Supply voltage for LCD
8	SHLD0	Shield for TMDS channel 0	23	V <sub>LCD</sub>	Supply voltage for LCD
9	RX0+	TMDS Differential Output(+) (CH 0)	24	V <sub>LCD</sub>	Supply voltage for LCD
10	RX0-	TMDS Differential Output(-) (CH 0)	25	PWR_ON	Power ON control signal input 3.3V(H:90%,L:10%)
11	SHLDC	Shield for TMDS channel C	26	HS_OUT	Hsync Output
12	RXC+	TMDS Differential Output(+) (CH C)	27	VS_OUT	Vsync Output
13	RXC-	TMDS Differential Output(-) (CH C)	28	GND	Ground
14	GND	Ground	29	OPEN	DDC -Clk(HDCP) for future use
15	OPEN	NC	30	OPEN	DDC -Data(HDCP) for future use

- Notes: 1. All GND(ground) pins should be connected together and should also be connected to the LCD's metal frame.
2. All V<sub>LCD</sub>(power input) pins should be connected together.
3. Input Level of TMDS signal is based on the Digital Visual Interface (DVI 1.0) Standard.

#### Rear view of LCM





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**Table 4 REQUIRED SIGNAL ASSIGNMENT FOR TMDS TRANSMITTER**

Graphics Controller		PanelLink		Flat Panel Controller	
24-bits	18-bits	SH160	SH161	18-bits	24-bits
B0 - 0		DIE0	QE0		B0 - 0
B1 - 0		DIE1	QE1		B1 - 0
B2 - 0	B0 - 0	DIE2	QE2	B0 - 0	B2 - 0
B3 - 0	B1 - 0	DIE3	QE3	B1 - 0	B3 - 0
B4 - 0	B2 - 0	DIE4	QE4	B2 - 0	B4 - 0
B5 - 0	B3 - 0	DIE5	QE5	B3 - 0	B5 - 0
B6 - 0	B4 - 0	DIE6	QE6	B4 - 0	B6 - 0
B7 - 0	B5 - 0	DIE7	QE7	B5 - 0	B7 - 0
G0 - 0		DIE8	QE8		G0 - 0
G1 - 0		DIE9	QE9		G1 - 0
G2 - 0	G0 - 0	DIE10	QE10	G0 - 0	G2 - 0
G3 - 0	G1 - 0	DIE11	QE11	G1 - 0	G3 - 0
G4 - 0	G2 - 0	DIE12	QE12	G2 - 0	G4 - 0
G5 - 0	G3 - 0	DIE13	QE13	G3 - 0	G5 - 0
G6 - 0	G4 - 0	DIE14	QE14	G4 - 0	G6 - 0
G7 - 0	G5 - 0	DIE15	QE15	G5 - 0	G7 - 0
R0 - 0		DIE16	QE16		R0 - 0
R1 - 0		DIE17	QE17		R1 - 0
R2 - 0	R0 - 0	DIE18	QE18	R0 - 0	R2 - 0
R3 - 0	R1 - 0	DIE19	QE19	R1 - 0	R3 - 0
R4 - 0	R2 - 0	DIE20	QE20	R2 - 0	R4 - 0
R5 - 0	R3 - 0	DIE21	QE21	R3 - 0	R5 - 0
R6 - 0	R4 - 0	DIE22	QE22	R4 - 0	R6 - 0
R7 - 0	R5 - 0	DIE23	QE23	R5 - 0	R7 - 0
B0 - 1		DIO0	QO0		B0 - 1
B1 - 1		DIO1	QO1		B1 - 1
B2 - 1	B0 - 1	DIO2	QO2	B0 - 1	B2 - 1
B3 - 1	B1 - 1	DIO3	QO3	B1 - 1	B3 - 1
B4 - 1	B2 - 1	DIO4	QO4	B2 - 1	B4 - 1
B5 - 1	B3 - 1	DIO5	QO5	B3 - 1	B5 - 1
B6 - 1	B4 - 1	DIO6	QO6	B4 - 1	B6 - 1
B7 - 1	B5 - 1	DIO7	QO7	B5 - 1	B7 - 1
G0 - 1		DIO8	QO8		G0 - 1
G1 - 1		DIO9	QO9		G1 - 1
G2 - 1	G0 - 1	DIO10	QO10	G0 - 1	G2 - 1
G3 - 1	G1 - 1	DIO11	QO11	G1 - 1	G3 - 1
G4 - 1	G2 - 1	DIO12	QO12	G2 - 1	G4 - 1
G5 - 1	G3 - 1	DIO13	QO13	G3 - 1	G5 - 1
G6 - 1	G4 - 1	DIO14	QO14	G4 - 1	G6 - 1
G7 - 1	G5 - 1	DIO15	QO15	G5 - 1	G7 - 1
R0 - 1		DIO16	QO16		R0 - 1
R1 - 1		DIO17	QO17		R1 - 1
R2 - 1	R0 - 1	DIO18	QO18	R0 - 1	R2 - 1
R3 - 1	R1 - 1	DIO19	QO19	R1 - 1	R3 - 1
R4 - 1	R2 - 1	DIO20	QO20	R2 - 1	R4 - 1
R5 - 1	R3 - 1	DIO21	QO21	R3 - 1	R5 - 1
R6 - 1	R4 - 1	DIO22	QO22	R4 - 1	R6 - 1
R7 - 1	R5 - 1	DIO23	QO23	R5 - 1	R7 - 1
Shift CLK	Shift CLK	IDCK	ODCK	Shift CLK	Shift CLK
VSYN	VSYN	VSYN	VSYN	VSYN	VSYN
HSYN	HSYN	HSYN	HSYN	HSYN	HSYN
DE	DE	DE	DE	DE	DE



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### 3-2-2. Backlight Interface

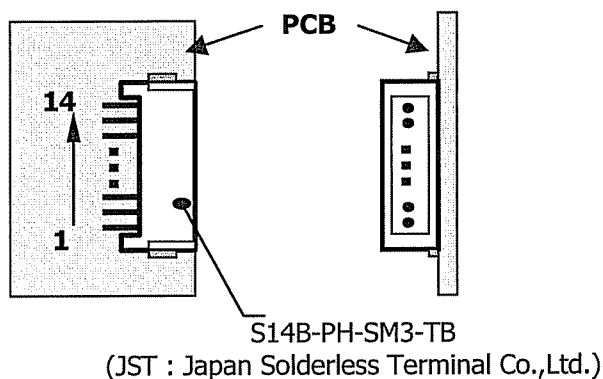
- Inverter Connector : S14B-PH-SM3 Side entry type (Manufactured by JST) or Equivalent
- Mating Connector : PHR-14(Manufactured by JST) or Equivalent

**Table 5. INVERTER CONNECTOR PIN CONFIGURATION**

Pin No	Symbol	Description	Remarks
1	VDDDB	Power Supply +24.0V (Back light)	
2	VDDDB	Power Supply +24.0V (Back light)	
3	VDDDB	Power Supply +24.0V (Back light)	
4	VDDDB	Power Supply +24.0V (Back light)	
5	VDDDB	Power Supply +24.0V (Back light)	
6	GND	Power Ground (Back light)	Note 1
7	GND	Power Ground (Back light)	
8	GND	Power Ground (Back light)	
9	GND	Power Ground (Back light)	
10	GND	Power Ground (Back light)	
11	OPEN	NC	
12	VON/OFF	Backlight On/off Signal	(On :4.0V~5V/Off :0.0~0.8V)
13	VBR	Brightness Adjustable Voltage	(Max :3.3V / Min :0.0V)
14	OPEN	NC	

Notes : 1. GND is connected to the LCD's metal frame.

#### Rear view of LCM





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### 3-3. Signal Timing Specifications

This is signal timing required at the input of the TMDS transmitter. All of the interface signal timing should be satisfied with the following specifications for it's proper operation.

**Table 6. TIMING TABLE**

ITEM		SYMBOL	Min	Typ	Max	Unit	Note
DCLK	Period	tCLK	6.49	6.41	6.33	ns	
	Frequency	fCLK	154	156	158	MHz	
Hsync	Period	tHP	1984	2144	-	tCLK	
	Width-Active	tWH	32	32	32		
Vsync	Period	tVP	1206	1212	-	tHP	
	Frequency	fV	56	60	64	Hz	
	Width-Active	tWV	2	3	-	tHP	
Data Enable	Horizontal Valid	tHV	1920	1920	1920	tCLK	
	Horizontal Back Porch	tHBP	16	128	-		
	Horizontal Front Porch	tHFP	16	64	-		
	Horizontal Blank	-	64	224	-		tWH+ tHBP+ tHFP
	Vertical Valid	tVv	1200	1200	1200	tHP	
	Vertical Back Porch	tVBP	3	6	-		
	Vertical Front Porch	tVFP	1	3	-		
	Vertical Blank	-	6	12	-		tWV+ tVBP+ tVFP

Note: Hsync period and Hsync width-active should be even number times of tCLK. If the value is odd number times of tCLK, display control signal can be asynchronous. In order to operate this LCM a Hsync, Vsync, and DE(data enable) signals should be used.

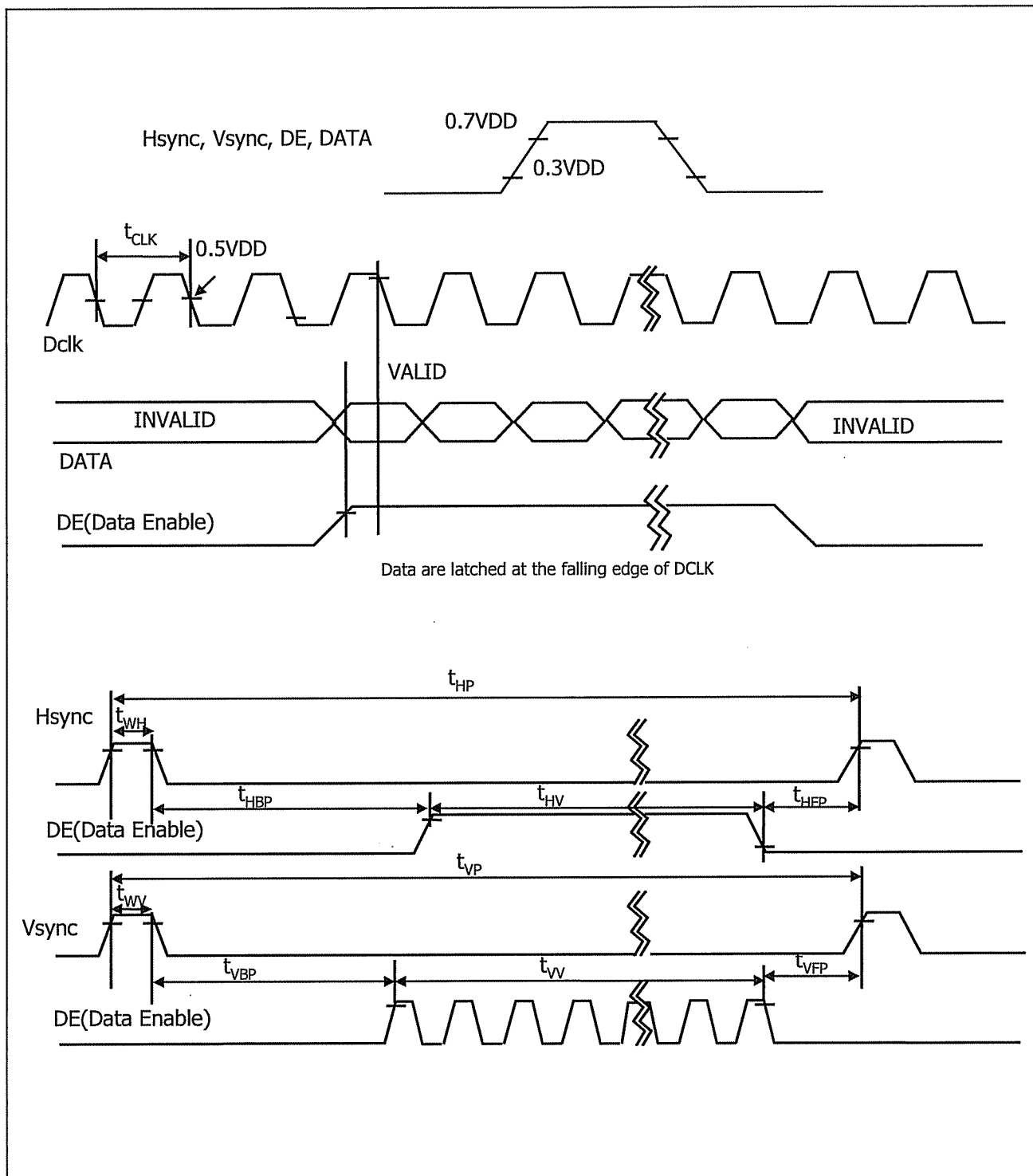
1. : The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
2. Vsync and Hsync should be keep the above specification.
3. Hsync Period, Hsync Width, and Horizontal Back Porch should be any times of of character number(8).



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### 3-4. Signal Timing Waveforms







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### 3-5. Color Data Reference

The luminance of each primary color(red,green,blue) is based on the 8-bit gray scale data input for the color; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

**Table 7. COLOR DATA REFERENCE**

Color		Input Color Data																							
		RED								GREEN								BLUE							
		MSB				LSB				MSB				LSB				MSB				LSB			
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Blue (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RED	RED (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (001)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	...	...								...								...							
	RED (254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	...	...								...								...							
	GREEN (254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	GREEN (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
BLUE	BLUE (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BLUE (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	...	...								...								...							
	BLUE (254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	BLUE (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

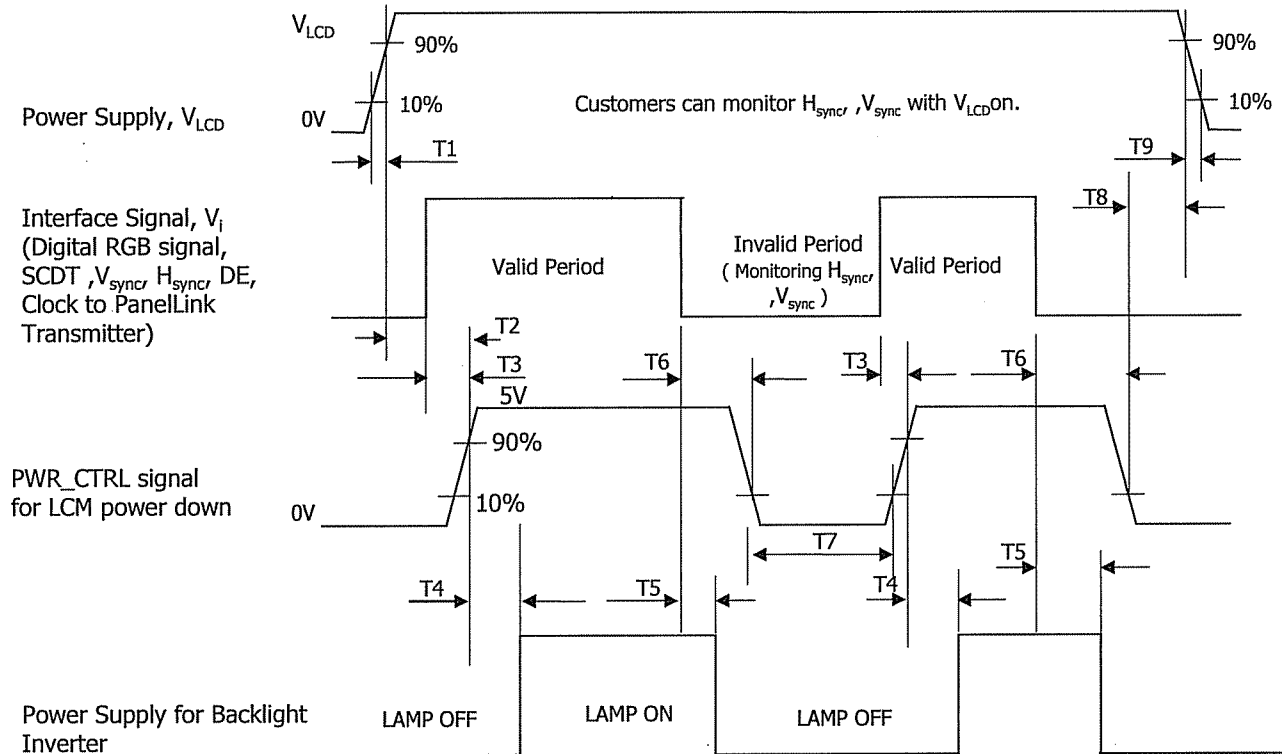
Note : Users should be input true 8 Bit data streams via TMDS transmitter.



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### 3-6. Power Sequence



**Table 8. POWER SEQUENCE**

Parameter	Values			Units
	Min	Typ	Max	
T1	-	-	10	ms
T2	-	-	50	ms
T3	-	-	50	ms
T4	100	-	-	ms
T5	-	-	50	ms
T6	-	-	80	ms
T7	400	-	-	ms
T8	50	-	-	ms
T9	-	-	10	ms

- Notes :
1. Please avoid floating state of interface signal at invalid period.
  2. When the interface signal is invalid, be sure to pull down the power supply for LCD  $V_{LCD}$  to 0V.
  3. Lamp power must be turn on after power supply for LCD and interface signal are valid.
  4. When connector is hot-plug and plug, T2 & T8 min spec can be 0ms.